REMARKS

The Official Action rejects Claims 1, 4, 6-8, 11, 19 and 20 under 35 U.S.C. §103(a) as being unpatentable over a published Japanese application to Yamada Hiroshi bearing Publication No. JP 06229426 in view of U.S. Patent No. 6,005,025 to Qamar S. Bhatia et al. The Official Action rejects the remainder of the claims, that is, Claims 2, 5, 9 and 12, under 35 U.S.C. §103(a) as being unpatentable over the '426 Japanese application in view of the Bhatia '025 patent and further in view of U.S. Patent No. 6,280,095 to Akimi Furukoshi et al. As described in detail below, the independent claims are patentably distinct from the cited references and the rejections are therefore traversed. In addition, new dependent Claims 21-28 have been added to further define other unique aspects of the claimed invention which define additional bases of patentability. In light of the foregoing amendments and the following remarks, Applicants respectfully request reconsideration of the present application and allowance of the amended set of claims.

Independent Claims 1 and 19 describe a bearing assembly having a pair of bearing members that are movable relative to one another. The pair of bearing members includes first and second members that define a space therebetween. The bearing surface of at least the first member has a coating of a polytetrafluoroethylene-based material having a thickness of about 0.003-0.007 inch. The coating is also defined to include a thermosetting stabilizer material. The bearing assembly of independent Claims 1 and 19 also includes a grease lubricant that occupies the space between the first and second members such that the polytetrafluoroethylene-based material and the grease lubricant act in conjunction with one another to lubricate the first and second members.

Independent Claims 7 and 20 recite a bearing assembly for a truck pivot joint bearing in an aircraft landing gear. The bearing assembly includes the metallic truck assembly defining an opening and a pin rotatably positioned in the opening of the truck assembly. The bearing assembly also includes a truck pivot bushing positioned at least partially in the opening defined by the truck assembly. The truck pivot bushing has an inner surface proximate the pin such that a space is defined between the inner surface of the truck pivot bushing and the pin. At least a portion of the inner surface of the truck pivot bushing has a coating of a self-lubricating,

greaseless material with a thickness of about 0.003-0.007 inch. This coating also includes a thermosetting stabilizer material. As further recited by independent Claims 7 and 20, the bearing assembly also includes a grease lubricant occupying the space between the pivot bushing and the pin.

The primary reference is a published Japanese application. Applicants have obtained a machine translation of the '426 Japanese application. A copy of the machine translation is attached for the Examiner's consideration, although Applicants do not vouch or otherwise attest as to the accuracy of the translation, as such was performed automatically. The '426 Japanese application describes a roller bearing having a plurality of balls **3** disposed between an inner ring **1** and an outer ring **2**. The roller bearing also includes holders **4** for circumferentially positioning the balls between the inner and outer rings. As described by the '426 Japanese application, the inner surfaces of the inner and outer rings and the ball may be coated with polytetrafluoroethylene (PTFE). See, for example, coatings **1a**, **2a** and **3a**. Moreover, the space between the inner and outer rings in which the balls reside may be sealed by shield plates **5** and the space between the inner and outer rings that is not already filled with the balls may be filled with a fluorine-type vacuum grease **6**.

The '426 Japanese application describes the PTFE coatings to consist of a plurality of islands, separated by recesses. As shown by Figures 2 and 5, for example, the PTFE coatings are not continuous, but are formed of a plurality of discrete islands. As such, particulates in the grease that would otherwise be ground up through contact between the balls and the rings and released as dust (see Figure 6) are now trapped in the recesses between islands of the PTFE coating, thereby advantageously reducing the dust produced during operation.

The '426 Japanese application does not teach or suggest that the PTFE coating includes a thermosetting stabilizer material, as recited by each independent claim. As such, the Official Action cites the Bhatia '025 patent. As previously described by the amendment dated March 11, 2004, the Bhatia '025 patent is directed to methods of dispersing solid additives, not to "reduce thermal degradation [sic] in high temperature applications" as stated in the Office Action. The section of the Bhatia specification cited in the Office Action (Column 13, line 43 - Column 14, line 5) discusses an example of the Bhatia process that includes "0.05 parts of a heat stabilizer,"

although the example does not mention the importance or use of the heat stabilizer for any particular purpose. However, upon reading the Bhatia '025 patent, it becomes clear that the process is directed to dispersing PTFE in a substance (e.g., a polycarbonate) to provide advantageous physical properties, such as impact strength, flammability, ductility, tensile strength, and tensile elongation. In particular, column 12 of the Bhatia '025 patent discloses the basic process, wherein a PTFE latex and a polycarbonate solution are mixed and directed through a nozzle where superheated steam is added to vaporize a solvent and water. As such, the polycarbonate encapsulates the PTFE to form coprecipitate particles ranging from 5 microns to 5 millimeters. Accordingly, the application of heat to the PTFE and polycarbonate mixture is critical to forming the desired coprecipitate particles, and the addition of the "heat stabilizer" is to regulate the application of heat to bring about the desired diameter of the particles.

Therefore, the "heat stabilizer" mentioned in the Official Action is not a "thermosetting stabilizer", as recited by the claimed invention. Not only are the words clearly different, but they describe different agents with different functions. Thus, even if the Bhatia '025 patent were combined with the '426 Japanese application, the combination of the cited references does not teach or suggest the bearing assembly as recited by the independent claims that has a coating of polytetrafluoroethylene-based material including a thermosetting stabilizer material, as recited by independent Claims 1 and 19 or that has a coating of a self-lubricating, greaseless material, including a thermosetting stabilizer material as recited by independent Claims 7 and 20.

Additionally, Applicants submit that the requisite motivation or suggestion to combine the Bhatia '025 patent with the '426 Japanese application is lacking. As described above, the Bhatia '025 patent is directed to an entirely different goal and provides an entirely different solution than the '426 Japanese application. In this regard, the Official Action indicates that it would have been obvious to have used a coating including a thermosetting stabilizer material taught by the Bhatia '025 patent in order to reduce thermal degradation in high temperature applications. However, the '426 Japanese application does not suggest that thermal degradation in high temperature applications is a concern and, in any event, the heat stabilizer mentioned by the Bhatia '025 patent is not described to reduce thermal degradation in high temperature applications, but to, instead, regulate the application of heat to bring about the desired diameters

of particles in a mixture of PTFE and polycarbonate. Thus, not only does any hypothetical combination of the '426 Japanese application and the Bhatia '025 patent fail to teach or suggest the bearing assembly of the claimed invention, but the Bhatia '025 patent cannot properly be combined with the '426 Japanese application as described above.

The cited references including, in particular, the '426 Japanese application also fail to teach or suggest that the PTFE coating has a thickness of about 0.003-0.007 inch, as recited by each independent claim. However, the Official Action indicates that it would have been an obvious matter of design choice to modify the '426 Japanese application such that the thickness of the PTFE coating was about 0.003-0.007 inch "since applicant has not disclosed that having such a thickness solves any stated problem or is for any particular purpose and it appears that the bearing would perform equally well with a wide range of PTFE-based material thicknesses." As an initial matter, Applicants note that the dependent claims reciting the thickness of the coating to be about 0.003-0.007 inch were indicated to be allowable in the previous Official Action dated December 31, 2003, thereby indicating that the thickness recitation did patentably distinguish the claimed invention from at least the references cited at that time.

Additionally, Applicants strongly disagree that the coating thickness is an obvious matter of design choice. In particular, the background portion of the present application describes the conventional practice of using coatings in which thicker coatings are thought to be more advantageous than thinner coatings. For example, page 3, lines 24-26 of the present application states that "[c]onventional practice teaches that a thicker coating of the greaseless material 116 will provide more lubrication for the bearing 110." Thus, the recitation of a thin PTFE-based coating having a thickness between 0.003 inch and 0.007 inch runs directly counter to conventional coating practice. In this regard, Applicants have discovered that a thin coating of PTFE-based material, preferably having a thickness of 0.003-0.007, used with a grease, provides advantageous results in a variety of applications, most notably in extreme loading conditions. In this regard, the space between the bearing surfaces of the first and second members, such as the truck pivot bushing and a pin extending therethrough, is relatively small, such as between 0.006 and 0.008 inch. In accordance with the claimed invention, the PTFE coating does not fill the entire space, as a grease lubricant is also disposed within the space. Thus, the PTFE coating

must be quite thin relative to conventional coatings in order to cooperate with the grease so as to provide the advantages offered by the claimed invention.

In this regard, page 9, lines 7-24 of the present application recites:

> A combination of a relatively thin coating of the greaseless material **50** coupled with the grease lubricant **58**, as disclosed by the present invention, flies in the face of conventional lubrication systems and methods. In this regard, it has been discovered that applying a relatively thin coating, such as about 0.005 inch, of the greaseless material **50** in combination with the grease lubricant that fills the remainder of the gap between the pivot bushing **30** and the pivot pin **24** allows dynamic bearing pressures to be increased dramatically to a level that approaches the allowable pressures for the base bearing material. ...As discussed above, conventional applications of greaseless material coatings call for much thicker coatings, which have been discovered to limit their use at relatively low dynamic bearing pressures and sliding velocities. Accordingly, the bearing assembly **20** according the present invention can operate longer under extreme conditions, such as when landing an aircraft on very rough runways where the bearing receives severe oscillations and sliding velocities. Specifically, the bearing assembly **20** according the present invention reduces the friction-generated heat sufficiently to substantially reduce or eliminate damage to the truck assembly **14** or inner cylinder assembly **26**.

As such, Applicants submit that it is not an obvious matter of design choice to modify the '426 Japanese application or any of the other cited references to have a PTFE-based material thickness of about 0.003-0.007 inch as recited by the claimed invention. In this regard, in contrast to the position taken by the Official Action, Applicants submit that the present application does disclose that a PTFE coating or a coating of self-lubricating, greaseless material having a thickness of 0.003-0.007 inch does solve a problem that was unaddressed by conventional approaches and thereby serves a particular purpose.

For each of the foregoing reasons, Applicants submit that the bearing assembly of independent Claims 1, 7, 19 and 20 is not taught or suggested by the cited references, taken either individually or in combination. Since the dependent claims include each of the recitations of a respective independent claim, the dependent claims are also patentably distinct from the cited references, taken either individually or in combination, for at least the same reasons as described above. However a number of the dependent claims include additional recitations that further patentably distinguish the claimed invention from the cited references.

In this regard, dependent Claims 2 and 9 recite that the coating has a solid particulate that is either flocked, powdered, fibrous, flaked or beaded. The Official Action cited the Furukoshi '095 patent for its apparent disclosure of such forms of solid particulates within a coating, such as a PTFE coating. Although Applicants' undersigned representative has reviewed the Furukoshi '095 patent, no reference to the form of particulates included within a coating, such as a PTFE coating, was discovered, including in the portion of the Furukoshi '095 patent cited by the Official Action. Thus, Applicants submit that the recitations of dependent Claims 2 and 9 also further patentably distinguish the claimed invention from the cited references including the Furukoshi '095 patent.

In addition, new dependent Claims 21-28 have been added with dependent Claims 21 and 25 reciting that the bearing surfaces of the first and second members are spaced apart by a distance between 0.006 inch and 0.008 inch, and dependent Claims 23 and 27 reciting that the inner surface of the truck pivot bushing and the pin are spaced apart by a distance between 0.006 inch and 0.008 inch. As none of the references teach or suggest this additional recitation, Applicants submit that Claims 21, 23, 25 and 27 further patentably distinguish the claimed invention from the cited references.

Further, new dependent Claims 22 and 26 recite that the PTFE-based coating extends continuously along the bearing surface of the first member. Similarly, new dependent Claims 24 and 28 recite that the self-lubricating greaseless material extends continuously along the inner surface of the truck pivot bushing. The recitation of a continuous coating is supported by the present application in that the specification describes the coating of the bearing surface of the first member, such as the inner surface of the truck pivot bushing, and Figure 7 depicts a continuous coating **50**. As described above, the '426 Japanese application describes the formation of the PTFE coating, not in a continuous manner as now recited by dependent Claims 22, 24, 26 and 28, but in islands in order to reduce the dust produced during use by trapping small particulates in the recesses between the islands. As neither the '426 Japanese application nor any of the other cited references, taken either individually or in combination, teach or suggest this additional recitation, Applicants submit that Claims 22, 24, 26 and 28 further patentable distinguish the claimed invention from the cited references.

For each of the foregoing reasons, Applicants submit that the rejections of the claims under 35 U.S.C. §103(a) are therefore overcome.

Conclusion

In view of the newly presented claims and the remarks presented above, it is respectfully submitted that all of the present claims of the present application are in condition for immediate allowance. It is therefore respectfully requested that a Notice of Allowance be issued. The Examiner is encouraged to contact Applicants' undersigned attorney to resolve any remaining issues in order to expedite examination of the present application.It is not believed that extensions of time or fees for net addition of claims are required, beyond those that may otherwise be provided for in documents accompanying this paper. However, in the event that additional extensions of time are necessary to allow consideration of this paper, such extensions are hereby petitioned under 37 CFR § 1.136(a), and any fee required therefore (including fees for net addition of claims) is hereby authorized to be charged to Deposit Account No. 16-0605.

Respectfully submitted,

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Abstract

(57)【要約】 (57) [Abstract]

【目的】 [Objective]

低発塵性が比較的良好で、かつ、耐久性に優れた転がり軸受を提供する。 Low dust generating property being relatively satisfactory, at same time, the roller bearing which is superior in durability is offered.

【構成】 [Constitution]

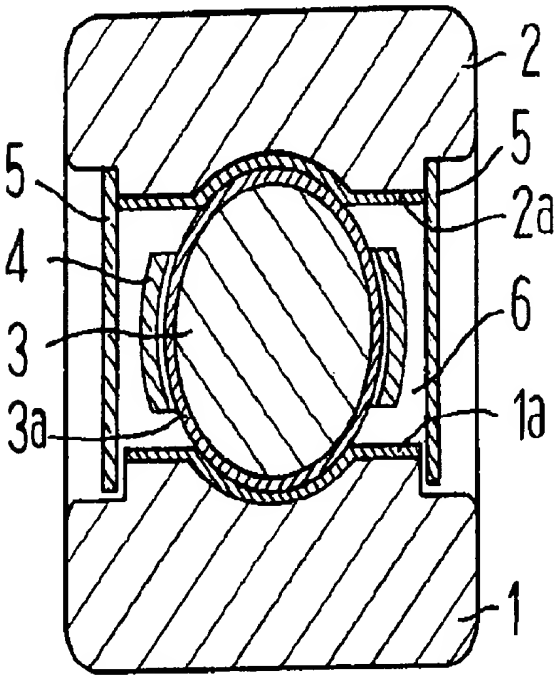
この軸受は、内輪 1、外輪 2、内・外輪 1、2 間に介在する複数のボール 3、ボール 3 を円周等間隔に保持する保持器 4、および、外輪 2 の両端内径部に装着された例えばSUS304製のシール this bearing configuration is done with bearing item such as shield sheet 5 of for example SUS304 which is mounted in both ends internal diameter part of holder 4, and outer race 2 which keep ball 3, ball 3 of plural which lies between inside

ド板 5 といった軸受部品で構成される。

そして、内・外輪 1、2 の転走面およびボール 3 の表面には、PTFE 例えば平均分子量が 5000 以下の PTFE の潤滑被膜 1a、2a、3a が形成され、軸受内にはフッ素系の真空グリース 6 が封入されている。

inner race 1, outer race 2, & between outer race 1, 2 in circumference equal spacing .

And, inside * PTFE for example average molecular weight lubrication coating 1a, 2a, 3a of PTFE of 5000 or less isformed by revolution running aspect of outer race 1, 2 and surface of ball 3, vacuum grease 6 of fluorine type is enclosed inside bearing .



Claims

【特許請求の範囲】

[Claim(s)]

【請求項 1】

[Claim 1]

転がり軸受を構成する部品のうち少なくとも転がり摩擦または滑り摩擦を生ずる表面にポリテトラフルオロエチレンからなる潤滑被膜を形成し、かつ、該軸受内にフッ素系の真空グリースを封入したことを特徴とする半導体製造設備用転がり軸受。

lubrication coating which consists of polytetrafluoroethylene in surface which among the part which roller bearing configuration are done at least causes rolling friction or rubbing friction is formed, at same time, roller bearing . for the semiconductor manufacture facility which designates that vacuum grease of fluorine type is enclosed into said bearing as feature

Specification

【発明の詳細な説明】

[Description of the Invention]

【0001】

[0001]

【産業上の利用分野】

[Field of Industrial Application]

本発明は、半導体製造設備に使用される転がり

this invention regards roller bearing which is used for

軸受に関する。

【0002】

【従来の技術】

転がり軸受の潤滑剤としてグリースが広く使用されている。

グリースは、潤滑作用をする基油に、それを半固形状に保持するための増稠剤、および、油の性質を改善するための添加剤を混合したものであるが、特に、半導体製造設備に代表される密封真空下で使用するためのものとして、真空グリースが知られている。

真空グリースとしては、例えば、蒸気圧の低いPFPE(パーフルオロポリエーテル)を基油とし、これにフッ素系化合物であるPTFE(ポリテトラフルオロエチレン)を増稠剤として混合したものがある。

真空グリースは、一般に、真空機器用軸受の潤滑剤として使用されている金、銀、二硫化モリブデン、PTFE 等の固体潤滑剤に比べ、潤滑性の点では優れているが低発塵性の点では劣っている。

そのため、真空グリースを封入した軸受は、良好な耐久性を示すものの、発塵量が多い。

【0003】

【発明が解決しようとする課題】

ところで、近年、半導体製造分野では半導体の集積度が増すにつれて回路パターンの線幅が微細化しており、軸受から排出されるパ-ティクルがパターン上に付着すると種々の弊害を引き起こす可能性があることから、軸受の特性として特に低発塵性が要求されるようになってきている。

その一方で、半導体製造設備において真に高い清浄度が要求されるのはウェーハの近傍部分であり、ウェーハから離れた部分(例えば、ウェーハ搬送ロボットで言えば、ウェーハハンドに対して回転軸部分等が該当する)にあっては清浄度の基準が、ウェーハの近傍部分に比べ、若干緩和される傾向にある。

したがって、択一的な言い方をすれば、このような環境下で使用される軸受には、ウェーハの近傍部分で使用される軸受ほどの高い低発塵性は必ずしも必要ではなく、むしろ耐久性が重要な特性の一つになってくると言える。

semiconductor manufacture facility .

[0002]

[Prior Art]

grease is widely used as lubricant of roller bearing .

grease in base oil which does lubricating action , is something which mixes thickener , in order to keep that in semisolid and additive in order toimprove property of oil , but vacuum grease is known especially, asthose in order to use under sealing up vacuum which is representedin semiconductor manufacture facility .

As vacuum grease , PFPE (perfluoropolyether) where for example vapor pressure is low is designated as the base oil , there are some which mix PTFE (polytetrafluoroethylene) which is a fluorine type compound in thisas thickener .

vacuum grease generally, in point of lubricity is superior as the lubricant of vacuum equipment skillful bearing in comparison with gold , silver , molybdenum disulfide , PTFE or other solid lubricant whichis used, but in point of low dust generating property it is inferior.

Because of that, as for bearing which encloses vacuum grease , althoughsatisfactory durability is shown, dust generation quantity is many.

[0003]

[Problems to be Solved by the Invention]

As by way, recently, with semiconductor manufacturing field degree of integration of semiconductor increases, linewidth of circuit pattern has done narrowing , when particle which is discharged from bearing deposits on pattern it hasreached point where especially low dust generating property is required from thefact that it is possibility which causes various adverse effect , as characteristic of the bearing .

As for on other hand, truly high cleanliness being required in the semiconductor manufacture facility with vicinal part of wafer , there being a portion (If you refer to for example wafer transport robot , rotating shaft part amount etc corresponds vis-a-vis the wafer hand) which leavesfrom wafer , reference of cleanliness , is a tendency which is easedsomewhat in comparison with vicinal part of wafer .

Therefore, if alternative expression is done, as for low dust generating property where about bearing which is used with vicinal part of wafer ishigh it is not necessary always in bearing which is used under the environment a this way, you can say that it becomes one of characteristic where rather durability is important.

勿論、一般使用の軸受に比べると、高い低発塵性は必要である。

【0004】

本発明の目的は、低発塵性が比較的良好で、かつ、耐久性に優れた転がり軸受を提供することにあり、主に、半導体製造設備において、ウェーハから離れた部分での最適使用を達成しようとするものである。

【0005】

【課題を解決するための手段】

本発明の半導体製造設備用転がり軸受は、転がり軸受を構成する部品のうち少なくとも転がり摩擦または滑り摩擦を生ずる表面にポリテトラフルオロエチレンからなる潤滑被膜を形成し、かつ、該軸受内にフッ素系の真空グリースを封入したものである。

【0006】

【作用】

PTFE 潤滑被膜が存在することにより、真空グリースに混合された増稠剤の破断が抑制される。

しかも、増稠剤はフッ素系化合物であり、潤滑被膜との親和性を期待し得るので、増稠剤の破断によって生じる破断粉が外部へ排出されにくくなる。

【0007】

【実施例】

以下、本発明の実施例について説明する。

【0008】

図1は、本発明を密封型の深溝玉軸受に適用した実施例を示す。

この軸受は、内輪 1、外輪 2、内・外輪 1、2 間に介在する複数のボール 3、ボール 3 を円周等間隔に保持する保持器 4、および、外輪 2 の両端内径部に装着された例えばSUS304製のシールド板 5 といった軸受部品で構成される。

そして、内・外輪 1、2 の転走面およびボール 3 の表面には、PTFE 例えば平均分子量が 5000 以下の PTFE(以下、簡単のため「低分子量PTFE」という。)の潤滑被膜 1a、2a、3a が形成され、軸受内にはフッ素系の真空グリース 6 が封入されている。

Of course, when you compare to bearing of generality use, highlow dust generating property is necessary.

[0004]

As for objective of this invention , low dust generating property being relativelysatisfactory, at same time, it is something which mainly, it triesthere will be times when roller bearing which is superior in durability isoffered, to achieve optimum use with portion which leaves from the wafer in semiconductor manufacture facility .

[0005]

[Means to Solve the Problems]

It is something where roller bearing for semiconductor manufacture facility of this invention forms the lubrication coating which consists of polytetrafluoroethylene in surface which among part which roller bearing configuration are done at least causes rolling friction or rubbing friction at same time, encloses vacuum grease of fluorine type into the said bearing .

[0006]

[Working Principle]

Breaking thickener which is mixed to vacuum grease due to fact that PTFE lubrication coating exists, is controled.

Furthermore, because thickener with fluorine type compound , can expect affinity of lubrication coating , breaking powder which it occurs with breaking thickener becomes difficult to be discharged to outside .

[0007]

[Working Example(s)]

You explain below, concerning Working Example of this invention .

[0008]

Figure 1 shows Working Example which applies this invention deeply to slot ball bearing of sealed type .

this bearing configuration is done with bearing item such as shield sheet 5 of for example SUS304 which is mounted in both ends internal diameter part of holder 4, and outer race 2 which keep ball 3, ball 3 of plural which lies between inside inner race 1, outer race 2, & between outer race 1, 2 in circumference equal spacing .

And, inside * PTFE for example average molecular weight lubrication coating 1a, 2a, 3a of PTFE (Below, for simplicity "low-molecular-weight PTFE " with you say.) of 5000 or less isformed by revolution running aspect of outer race 1, 2 and surface of ball 3, vacuum grease 6 of fluorine type is enclosed inside bearing .

【0009】

潤滑被膜 1a、2a、3a は、低分子量 PTFE(例えば、日本アチソン製 ARC7)を、25cm 離れた位置から被膜形成面にスプレーして付着させたものである。

ここで、低分子量 PTFE について簡単に説明しておくと(詳細については、本出願人による特願平 3-190150 号等参照)、従来より、軸受の固体潤滑剤として一般に用いられている PTFE は平均分子量が 1×10^5 以上、主に、1×10^6~1×10^7 のものであるが、低分子量 PTFE はこれら一般の PTFE に比べ剪断強度が著しく小く、また、転着性に優れている。

そのため、低分子量 PTFE は、それ自体優れた潤滑性、低発塵性を有する。

【0010】

PTFE としては、上記 ARC7 の他、バイダックス AR、バイダックス 1000(いずれもデュポン社製)、MP1200、MP1300(いずれも三井フロロケミカル社製)、ルブロン D-1(ダイキン工業社製)等がある。

尚、被膜の平均厚さは 0.6μm 程度であるが、図 1 ではこれをかなり誇張している。

また、図 1 では内・外輪 1、2 の外表面のうち嵌合面等に潤滑被膜 1a、2a が形成されていないが、これは、マスキングによって被膜処理を施さない、あるいは、最終製品となる前に除去したものである。

【0011】

図 2 は、一例として、内輪 1 の転走面を模式的に示したものである(外輪 2 の転走面、ボール 3 の表面も同様である)。

潤滑被膜 1a は、転走面に島状に形成されている。

低分子量 PTFE の被膜コーティング法として、上述したスプレー法の他に浸漬法等があるが、スプレー法によれば、低分子量 PTFE の分散液を噴霧状にして皮膜形成面に吹き付けるため、潤滑被膜 1a は同図に示すような島状分布になり易い。

潤滑被膜 1a は、軸受内に封入された真空グリ

[0009]

lubrication coating 1a, 2a, 3a, 25 cm from location which leaves spray doing the low-molecular-weight PTFE (for example Acheson (Japan) Ltd. (DB 69-067-1110) make ARC7), on coating formation aspect, is something which deposits.

Here, when you explain simply, concerning low-molecular-weight PTFE (Concerning details, with this applicant reference such as Japan Patent Application Hei 3-190150 number), PTFE which is used generally from until recently, as solid lubricant of bearing average molecular weight 1 X 10⁵ or more, mainly, is something of 1 X 10⁶~1X 10⁷, but as for low-molecular-weight PTFE shear strength is considerable in comparison with these general PTFE small *, in addition, is superior in transferring .

Because of that, low-molecular-weight PTFE that itself has lubricity , low dust generating property which issuperior.

[0010]

As PTFE , other than above-mentioned ARC7, [baidakkusu] AR, [baidakkusu]1000 (Which Dupont Co. make), MPa 1200, MPa 1300 (Which Mitsui fluoro chemical supplied), there is a Lubron D-1 (Daikin Industries Ltd. (DB 69-054-0356) supplied) etc.

Furthermore average thickness of coating is 0.6;mu m extent , but with Figure 1 this is exaggerated quite.

In addition, with Figure 1 inside * lubrication coating 1a, 2a is not formed to theinside mating surface etc of outer surface of outer race 1, 2 . This does not administer coating with masking , or, before becoming final product , it is something which is removed.

[0011]

Figure 2 is something which shows revolution running aspect of inner race 1 in schematic as one example , (Revolution running aspect of outer race 2, also surface of the ball 3 is similar.).

lubrication coating 1a is formed to island to revolution running aspect.

As coating coating method of low-molecular-weight PTFE , there is a immersion method etc to other than the spray method which description above is done, but in order to blow to the film formation aspect according to spray method , with dispersion of low-molecular-weight PTFE as atomized state , lubrication coating 1a, is easy to become kind of island distribution which isshown in same Figure .

As for lubrication coating 1a, it is covered with vacuum

ース 6 によって覆われている。

【0012】

真空グリース 6 はフッ素系の真空グリースであり、例えば、蒸気圧の低い PFPE(パーフルオロポリエーテル)を基油 6a とし、これにフッ素系化合物である PTFE(ポリテトラフルオロエチレン)を増稠剤 6b として混合したものである。

フッ素系の真空グリースとしては、ブレーコート 601(カストロール製)等がある。

尚、フッ素系真空グリースの増稠剤である PTFE は、フッ素系グリースの増稠剤として使用される PTFE よりも平均分子量が大きい。

【0013】

図 3 は、上記構成の転がり軸受(真空グリース +PTFE 潤滑被膜:軸受 A とする)と、従来品(真空グリースのみ:軸受 B とする)とについて行なった耐久性試験の結果を示す。

耐久性試験は、軸を支承させた 2 個の試験軸受を、室温、真空度 10^{-6}Torr 以下、スラスト荷重 10N、回転数 2500rpm の条件下に回転させ、2 個の試験軸受の摩擦トルクの総和が 10^{-2}Nm に達した時点を寿命とした。

同図に示すように、軸受 A は軸受 B に比べ約 1.1 倍以上の耐久性を示した。

【0014】

図 4 は、軸受 A と軸受 B とについて行なった発塵試験の結果を示す。

発塵試験は、回転数:50rpm、スラスト荷重:10N、真空度:10^{-6}Torr 以下、温度:室温の条件下で試験軸受を回転させ、試験軸受の直下に配置した発塵検出器により発塵量を測定した。

同図に示すように、軸受 A の発塵量は軸受 B の 100 分の 1 以下と大幅に減少しており、軸受 A は軸受 B に比べ極めて良好な低発塵性を示した。

【0015】

本実施例品である軸受 A において、低発塵性が大幅に改善されている理由として、次に示す理由が考えられる。

grease 6 which is enclosed into bearing .

[0012]

vacuum grease 6 with vacuum grease of fluorine type , designates PFPE (perfluoropolyether) where for example vapor pressure is low as base oil 6a, it is something which mixes PTFE (polytetrafluoroethylene) which is a fluorine type compound in this as thickener 6b.

As vacuum grease of fluorine type , there is a fluctuation -co-jp7 601 (deposit jp7 roll make) etc.

Furthermore as for PTFE which is a thickener of fluorine type vacuum grease , average molecular weight is large as thickener of fluorine type grease in comparison with PTFE whichis used.

[0013]

Figure 3 shows result of durability test which was done roller bearing of above-mentioned configuration (vacuum grease +PTFE lubrication coating :bearing A it does) with, conventional goods (Only vacuum grease the:bearing B does) with concerning.

durability test test bearing of 2 axis is supported, turning under condition of room temperature , degree of vacuum 10⁻⁶Torr or less , thrust load 10N, rotation rate 2500rpm , designated time point where sum of the frictional torque of test bearing of 2 reaches to 10 ⁻²Nm as lifetime .

As shown in same Figure , bearing A showed durability of approximately 1.1 times or more in comparison with bearing B.

[0014]

Figure 4 shows result of dust generation test which was done concerningwith bearing A and bearing B.

dust generation test measured dust generation quantity due to dust generation detector which under condition of rotation rate :50rpm , thrust load :10N, degree of vacuum :10⁻⁶Torr or less , temperature :room temperature turning, arranges test bearing in directly below of test bearing .

As shown in same Figure , 1/100 or less of bearing B greatly we haddecreased dust generation quantity of bearing A, bearing A showed quite thesatisfactory low dust generating property in comparison with bearing B.

[0015]

You can think reason which is shown next as reason which isimproved in bearing A which is a this working example item, low dust generating property greatly .

図 5(軸受 A)および図 6(軸受 B)を参照しながら説明すると、まず、軸受 B において多量の発塵が発生する要因は、真空グリース 6 に含まれている増稠剤 6b が、ボール 3 と転走面との間の剪断力によって破断されて微小な破断粉 6b1 となり、この破断粉 6b1 の多くがそのまま軸受外に排出されてしまうことによる。

While Figure 5 (bearing A) and referring to Figure 6 (bearing B), when you explain,factor where dust generation of large amount occurs first, in bearing B the thickener 6b which is included in vacuum grease 6, being broken with shear stress between ball 3 and revolution running aspect, becomes fine breaking powder 6b1, By fact that many of this breaking powder 6b1 are discharged thatway outside bearing .

これに対し、軸受 A においては、

Vis-a-vis this, regarding bearing A,

【0016】

[0016]

(1)潤滑被膜 1a がボール 3 と転走面との間に介在することによって、これが緩衝作用をなし、増稠剤 6b の破断を抑制する、

By fact that (1) lubrication coating 1a lies between between ball 3 and therevolution running aspect, this forms buffering action , controls breaking the thickener 6b,

【0017】

[0017]

(2)潤滑被膜 1a が島状に分布しており、増稠剤 6b の破断粉 6b1 が島 1a2 と島 1a2 との間の凹状部分に入り込み、外部に排出されにくくなる。

(2) lubrication coating 1a distribution has done in island , breaking powder 6b1 of thickener 6b enters into recessed part amount between island 1 a2 and the island 1 a2, becomes difficult to be discharged in outside .

言い換えると、破断粉 6b1 が島 1a2 と島 1a2 との間の凹状部分によって捕捉され、外部に排出されにくくなる、

paraphrase * with, breaking powder 6b1 trapping is done at recessed part amount between island 1 a2 and island 1 a2, becomes difficult to bedischarged in outside ,

【0018】

[0018]

(3)増稠剤 6b である PTFE と潤滑被膜 1a の形成材料である低分子量 PTFE とがフッ素系化合物として同種であるため、両者の親和性が期待でき、増稠剤 6b の破断粉 6b1 が潤滑被膜 1a 上に転着し易く、また、潤滑被膜 1a の潤滑粉 1a1 と伴に上記凹状部分に転着し易い、

Because low-molecular-weight PTFE which is a molding material of PTFE and lubrication coating 1a whichare a (3) thickener 6b it is a same kind as fluorine type compound , be able to expect affinity of both , breaking powder 6b1 of thickener 6b is easy to do transfer on lubrication coating 1a, in addition, in lubrication powder 1a1 and Ban of lubrication coating 1a inabove-mentioned recessed part amount transfer to do is easy,

【0019】

[0019]

ために、発塵量が著しく減少したものと考えられる。

For sake of, it is thought thing which dust generation quantitydecreases considerably.

そして、上記理由中、特に潤滑被膜 1a を島状分布としたことによる影響が最も大きいと思われる。

It is thought that and, in above-mentioned reason, influence islargest by fact that especially lubrication coating 1a is designated as the island distribution .

【0020】

[0020]

軸受 A において、耐久性がやや改善されているのは、真空グリース 6 の良好な潤滑性と、低分子量 PTFE の良好な潤滑性との相乗効果によるものと考えられる。

In bearing A, that durability is a little improved, it is thought thething with satisfactory lubricity of vacuum grease 6 and multiplier effect of thesatisfactory lubricity of low-molecular-weight PTFE .

【0021】

[0021]

尚、潤滑被膜 1a、2a、3a は島状分布に限らず、連続した島状分布(島と島とを薄い被膜部分で連続させたもの)、一様分布としても良い。

Furthermore lubrication coating 1a, 2a, 3a island distribution which is continued not just island distribution ,(Island and island those which are continued with thin coating portion .), as even distribution is good.

また、潤滑被膜1a、2a、3aの形成材料として、例示した低分子量 PTFE の他、一般に使用されている PTFE を使用することもでき、その場合でもかなりの効果を期待し得る。

さらに、軸受形式は、図 1 に示す深溝玉軸受に限らず、広く転がり軸受一般に適用が可能である。

【0022】

【発明の効果】

以上説明したように、本発明の半導体製造設備用転がり軸受は、転がり軸受を構成する部品のうち少なくとも転がり摩擦または滑り摩擦を生ずる表面にポリテトラフルオロエチレンからなる潤滑被膜を形成し、かつ、該軸受内にフッ素系の真空グリースを封入した構成を有するので、従来の真空グリースのみを封入したものに比べ、同等以上の耐久性を有し、しかも、極めて良好な低発塵性を有する。

したがって、本発明によれば、半導体製造設備において、例えば、ウェーハ搬送ロボットにおける回転軸部分等のように、比較的良好な低発塵性と、高い耐久性とが同時に要求される部分に使用するのに最適な転がり軸受を提供することができる。

【図面の簡単な説明】

【図1】

本発明の実施例に係わる密封型の深溝玉軸受を示す断面図である。

【図2】

図 1 における内輪の転走面部分を模式的に示す拡大断面図である。

【図3】

耐久性試験の結果を示す図である。

【図4】

発塵試験の結果を示す図である。

【図5】

図 1 における内輪の転走面部分を模式的に示す拡大断面図である。

【図6】

In addition, other than low-molecular-weight PTFE which was illustrated as molding material of lubrication coating 1a, 2a, 3a, it can also use PTFE which is used generally evenwith in that case expect considerable effect can.

Furthermore, as for bearing form , roller bearing application is possiblewidely generally not just slot ball bearing which is shown in Figure 1 deeply.

[0022]

[Effects of the Invention]

As above explained, roller bearing for semiconductor manufacture facility of this invention to form the lubrication coating which consists of polytetrafluoroethylene in surface which among part which roller bearing configuration are done at least causes rolling friction or rubbing friction , at same time, because it possesses configuration whichencloses vacuum grease of fluorine type into said bearing , in those which encloseonly conventional vacuum grease comparing, To possess durability of same or greater , furthermore, it possesses quite thesatisfactory low dust generating property .

Therefore, according to this invention , in semiconductor manufacture facility , in order in for example wafer transport robot rotating shaft part amount or other , relatively optimum roller bearing can be offered in order touse for portion where satisfactory low dust generating property and high durability are required simultaneously.

[Brief Explanation of the Drawing(s)]

[Figure 1]

It is a sectional view which shows deeply slot ball bearing of sealed type which relatesto Working Example of this invention .

[Figure 2]

It is a enlarged cross section diagram which shows revolution running surface portion of inner race in Figure 1 in schematic .

[Figure 3]

It is a figure which shows result of durability test.

[Figure 4]

It is a figure which shows result of dust generation test.

[Figure 5]

It is a enlarged cross section diagram which shows revolution running surface portion of inner race in Figure 1 in schematic .

[Figure 6]

従来品における内輪の転走面部分を模式的に示す拡大断面図である。

It is a enlarged cross section diagram which shows revolution running surface portion of inner race in conventional goods in schematic .

【符号の説明】

[Explanation of Symbols in Drawings]

1

内輪

inner race

1a

潤滑被膜

lubrication coating

2

外輪

outer race

2a

潤滑被膜

lubrication coating

3

ボール

ball

3a

潤滑被膜

lubrication coating

6

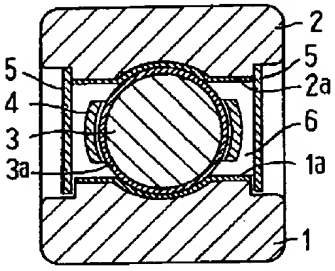
真空グリース

vacuum grease

Drawings

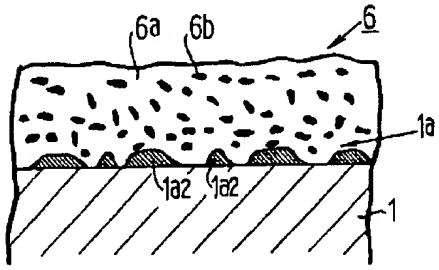
【図1】

[Figure 1]

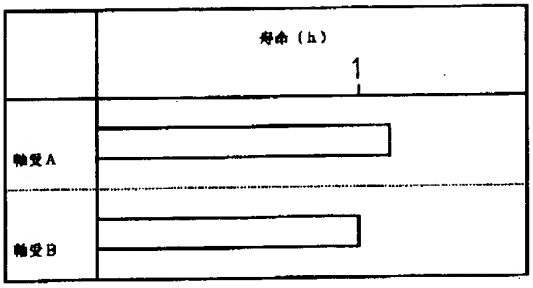


【図2】

[Figure 2]



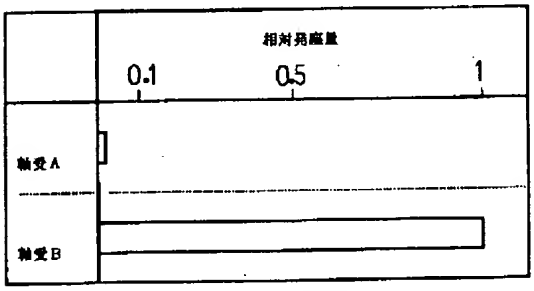
【図3】 [Figure 3]



（軸受Bの寿命を1として示す。）

軸受A ： 本実施例品（真空グリース＋ＰＴＦＥ調滑被膜）
軸受B ： 従来品（真空グリースのみ）

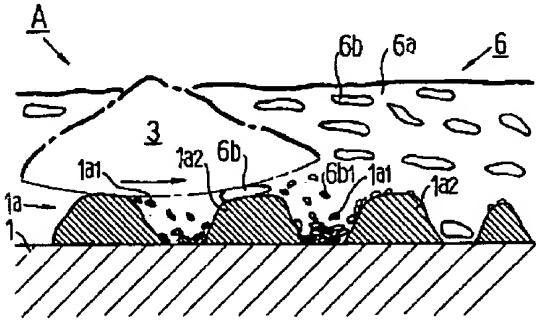
【図4】 [Figure 4]



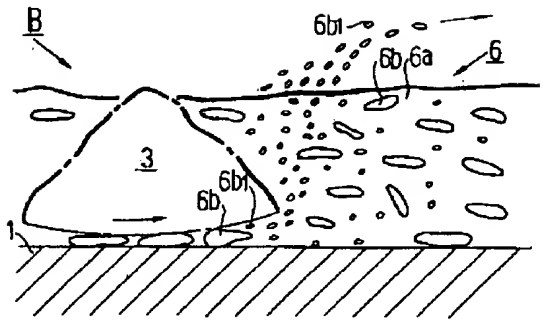
（軸受Bの相対発塵量を1として示す。）

軸受A ： 本実施例品（真空グリース＋ＰＴＦＥ調滑被膜）
軸受B ： 従来品（真空グリースのみ）

【図5】 [Figure 5]



【図6】 [Figure 6]


B
6b1
6b
6a
6
3
6b1
6b
1